Reports

Intermittent Conditioned Reinforcement in Chimpanzees

If the delivery of food is correlated with a skeletal response made by a hungry organism (for example, pressing a lever), there will be a subsequent increase in the frequency of the response. We refer to the delivery of the food as reinforcement. The frequency of the response can also be increased if delivery of an object that is exchangeable for food (for example, a coin) is correlated with the response. We refer to the delivery of such an object as conditioned reinforcement.

The study of reinforcement has shown that highly stable patterns of responding can be developed when food is delivered according to a schedule (*1*). Under the 5-minute fixed-interval schedule, reinforcement is correlated with the first response, which occurs after a 5-minute interval has elapsed. Each successive interval is timed from the reinforcement that terminates the preceding one. The behavior associated with this schedule is characterized by a pause at the start of each interval followed by a positively accelerated rate of responding to the point of reinforcement (*1*). Under the 20-response fixed-ratio schedule, the reinforcement is correlated with every 20th response. The behavior associated with this schedule is characterized by high, stable rates of responding (*1*). The present paper describes a method that utilizes these schedules for the study of conditioned reinforcement (*2*).

The subjects were two male chimpanzees maintained at 80 to 85 percent of their normal body weight. Initially, they received food every time they pressed a lever. After 20 reinforcements, they were shifted to a 5-minute fixed-interval schedule and remained on this schedule for 180 hours. An overhead light indicated that the lever was connected, and the animals pressed the lever only when this light was on. In the next phase of training, each subject was given plastic poker chips at the start of each session and was trained to obtain food by inserting the poker chips through a slot in a Plexiglas window. One-minute periods in which the window was illuminated by a red light alternated with 2-minute periods of no illumination, but the overhead light remained off. The subjects soon learned that insertion of a poker chip yielded a piece of food only when the red light was on. Each animal received more than 500 reinforcements during this training. In the final phase, the overhead light was on, and pressing the lever resulted in the scheduled delivery of poker chips—that is, conditioned reinforcement. The procedures were programmed, and the results were recorded automatically by relay switching circuits, timers, electromagnetic counters, and a cumulative-response recorder.

The first schedule of conditioned reinforcement was a 5-minute fixed interval. At the end of each hour, the red light came on for 10 minutes, and the animal could exchange for food the poker chips it had obtained during the hour. The first cumulative response record in Fig. 1 shows the third hour on this schedule for one subject. The rates of responding were low, and further investigation revealed that behavior could not be sustained on this schedule unless poker chips could be exchanged for food more frequently (*3*).

The next procedure combined both interval and ratio schedules in a multiple schedule (*1*) as follows. An orange or green light above the lever indicated whether the 5-minute fixed interval or the 20-response fixed ratio, respectively, was in effect. The two conditions were programmed randomly with the restriction that the same one could not occur more than three times in succession. The frequency with which poker chips could be exchanged for food had little effect on the behavior that developed under this schedule (*3*). The second and third records in Fig. 1 present the last 2 hours of a session in which the animal had to obtain 60 poker chips before it could exchange them for food. The two distinct patterns of responding that can be identified indicate that the behavior came under the control of the orange and green stimuli. The fixed-ratio segments include few pauses and are characterized by rates of responding that exceed one response per second. The fixed-interval segments are characterized by low rates of responding and sometimes include only one response; however, high rates occasionally occurred in intervals after 40 poker chips had been delivered (Fig. 1*A* and *B*). Observation of the animals revealed that such bursts of responding were usually accompanied by general activity and loud vocalizations. This suggests that the imminence of the exchange of poker chips for food had an emotional effect that momentarily attenuated the stimulus control.

The third schedule of conditioned reinforcement was the 20-response fixed ratio alone. The fourth record in Fig. 1 presents the first session on this schedule after 120 hours on the multiple schedule. Although there were long pauses in the middle of the session, all responding occurred at the characteristic ratio rate. The almost continuous responding near the end of the session included 960 responses that were emitted in 6 minutes. In subsequent sessions, the pauses dropped out and the 60 poker chips were usually obtained within 15 minutes.

The importance of conditioned rein-

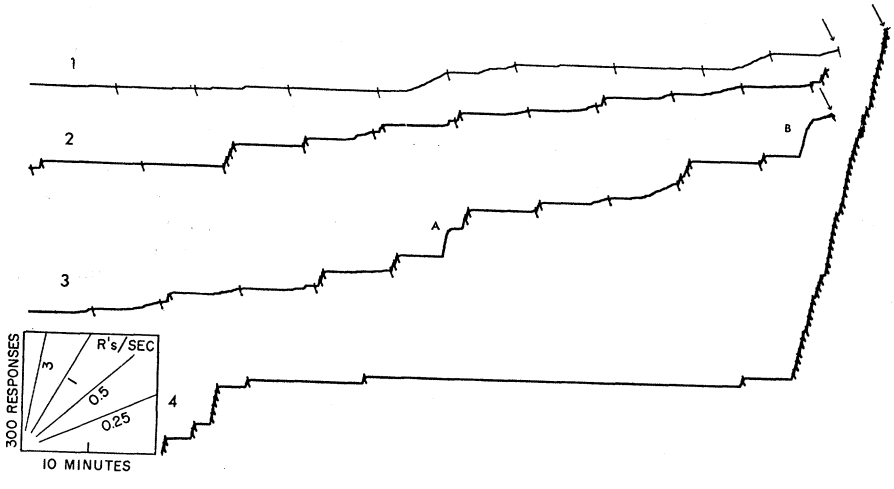

Fig. 1. Representative cumulative response curves for chimpanzee 119 showing three schedules of conditioned reinforcement. The vertical pips indicate delivery of poker chips, and the arrows indicate exchanges of poker chips for food.

forcement (for example, money) in developing and maintaining human behavior is apparent. However, the rapid attenuation of the effectiveness of conditioned reinforcement when food delivery is delayed is a serious difficulty in most experimental studies (*4*). The method employed in the present study should make it possible to investigate many behavioral processes independently of the effects of food ingestion during a session. For example, the effect of varying the amount of conditioned reinforcement by delivering one or more poker chips per reinforcement could be investigated. Also, one could assess the effects of "inflating" this coin of the realm by requiring the subject to insert more than one poker chip to obtain one piece of food. The significance of such variables will have to be determined by further research.

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References and Notes

1. C. B. Ferster and B. F. Skinner, *Schedules of Reinforcement* (Appleton-Century-Crofts, New York, in press); B. F. Skinner, *Am. Psychol.* 8, 69 (1953).
2. This investigation was supported in part by research grant M-1005 from the Institute of Mental Health of the National Institutes of Health, U.S. Public Health Service, and in part by the National Science Foundation.
3. Two manuscripts presenting in detail the effects of delays in exchanging poker chips for food are in preparation.
4. For example, I. F. Saltzman, *J. Comp. and Physiol. Psychol.* 42, 161 (1949); J. F. Hall, *ibid.* 44, 246 (1951).

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Generality of Some Academic Reputations

College students often state their beliefs that some courses, fields of study, and professors, are "hard" or "easy." Descriptions of professors occasionally include references to their competence. There is little objective evidence that students on a single campus agree with one another to any statistically reliable extent regarding "hard" or "easy" courses, majors, or professors. When the Selective Service System authorized the nationwide administration of a scholastic aptitude test to help determine who should be deferred from the draft, 339,000 college students were tested in 1951. Chauncey (*1*) and Wolfle and Oxtoby (*2*) present data that compare test results from students in different areas of study. The present study (*3*) was conducted to (i) measure the extent to which college students at a western state university agreed in their recognition of "hard" and "easy" reputations supposedly acquired by different courses, majors, and professors, (ii) compare rankings of fields of study by reputation for difficulty with the Wolfle-Oxtoby rankings of students majoring in different fields, and (iii) compare the reputation rankings with grades given during one quarter by professors in the various departments at this same school.

The student population was stratified for class (freshman, sophomore, and so forth) and sex, and a random sample was drawn. Each subject was contacted by telephone, told how he had been selected to participate in a research study, told that the nature of the study could not be discussed with him until all respondents were assembled at one place and time, and asked to be at the Student Union Auditorium at a specific time.

Of 236 students contacted, 90 participated in the study. When the participating sample is compared with the total population with respect to the stratification variables utilized, the lowest probability (p) that the deviations of sample statistics from population parameters could occur by chance alone is approximately 0.3. This p value refers to the representativeness of the sample of graduate students participating in the study. The remaining p values range from 0.6 to 0.9. Therefore, the null hypothesis—that the deviations are not significant—is accepted.

The 90 subjects were simultaneously presented with a questionnaire that explained the nature of the study and stressed the subjects' anonymity. The questionnaire also cautioned against answering the questions on the basis of personal experience with various courses, professors, or majors and requested responses on the basis of the reputation that each participant thought the course, major, or professor had acquired (*4*).

The questionnaire did not structure the breakdown of majors, and the respondents tended to follow the breakdown employed by the university. To facilitate comparisons between these data and those of Wolfle and Oxtoby, I grouped the reputation data into the categories employed by Wolfle and Oxtoby. The same groupings were employed in comparing mean grade points per credit given in the autumn quarter of 1950–51 by professors in these various fields at the university where this study was conducted. Some fields—for example, nursing and engineering—were not represented on this campus. Therefore, the only field groupings compared were those that were common to the Wolfle-Oxtoby breakdown and the university where this study was conducted. Table 1 compares the different fields with respect to how students majoring in them on a nationwide basis performed on the Selective Service College Qualification Test (SSCQT), the reputation these fields have for difficulty on the campus studied, and their actual difficulty on the campus studied as measured by mean grade points per credit given 3 years earlier by the professors in the different departments. Kendall's tau coefficient, a rank-order test of relationships, seemed to be appropriate for correlating these three rankings. The correlation between the SSCQT rankings and the reputation for difficulty rankings is + .61, and the correlation between the local reputation for difficulty and the actual difficulty, locally, of these fields of study, is only + .39. In addition to the obvious possibility that the difference between the + .61 and + .39 correlations is a function of chance, there are several interesting explanations of this finding, and they are not mutually exclusive.

Common sense might dictate that local reputations for difficulty should correlate more highly with local grading. That both correlate more highly with the SSCQT results than with each other suggests that the reputation results obtained locally are to some degree representative of reputations (attitudes) attributed nationally. It also suggests that professors have a perception of themselves as representatives of their fields of specialty that is fairly congruent with the more widespread attitudes mentioned. Thus, it appears that the formation of these academic attitudes resembles the formation of other types of attitudes—for example, toward minority groups. That is, they derive from contact with the attitude more than from contact with the referent of the attitude. Wolfle and Oxtoby comment, "In conclusion, those fields which have reputations of requiring abstract and rigorous thinking (*e.g.*, physics, chemistry, law) attract

Table 1. Rankings of fields of study by SSCQT performance, reputation for difficulty, and strictness of grading on one campus.*

Fields of study	Rank of average AB (SSCQT) (2)	Rank of reputation by difficulty (local)	Rank by strictness of grading (local)
Physical sciences	1	2	1
Chemistry	2	1	2
English	3.5	4	3
Psychology	3.5	5	5
Fine arts	5	3	9
Business and commerce	6	9	4
Education	7	7	8
Home economics	8	6	6
Physical education	9	8	7

* Kendall's tau (SSCQT versus reputation), + .61; Kendall's tau (SSCQT versus grades), + .61; Kendall's tau (reputation versus grades), + .39.